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Studies on *Plasmodium falciparum* Infection Rates among Patients Attending General Hospitals in Benue State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors OAA, OA, FTI and MMM designed the stud. Authors AOA and VUO performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OAA and VUO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Plasmodium falciparum is the most virulent and prevalent malaria parasite in Nigeria .This study aimed to determine the prevalence of malaria infection among patients at General Hospitals in Benue State. A total of 1200 patients were examined in this study. Blood samples were collected by finger prick onto clean slides and into the round sample well of *Pf*RDTs. Thick and thin blood films were prepared for microscopic examination. The overall prevalence of malaria infection was 34.8%. A questionnaire was used to determine some demographic factors. Prevalence of malaria in relation to residence, rural area recorded higher prevalence of 42.2% than urban area with prevalence of 23.8%. Chi square analysis showed a significant difference ($p < 0.05$) in prevalence in relation to residence. The Prevalence of malaria in relation to age groups, age between 6-10 and 7-15 recorded higher infection rate of 54.5% and 51.5% respectively. While, age group >46 recorded 17.5%. The female patients 36.2% were more infected than the males 33.1%.Patients that had informal education recorded higher prevalence rate of 89.2% and those that are farmers had 57.9%. Chi square analysis however showed that the difference was significant ($p < 0.05$). A significant

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difference (P<0.05) was observed between patients that used insecticide spray alone as malaria preventive methods (70.1%) compared to patients that used combined methods of prevention (17.2%). Malaria still remains prevalent among patients in Benue State, Nigeria.

Keywords: Plasmodium falciparum; infections; general hospitals; Benue State.

1. INTRODUCTION

Malaria is an acute febrile illness [1].Malaria is preventable and treatable, but continues to have a devastating impact on people's health and economy globally [2]. According to World Health Organization, Nigeria suffers the world's greatest malaria burden, with approximately 25% cases and almost 24% of all global malaria deaths [1], while 97 % of the total population (approximately 173 millions) is at risk of infection. Moreover, malaria accounts for 60 % of outpatient visits to hospitals and leads to approximately 11 % maternal mortality and 30 % child mortality, especially among children less than 5 years [3]. *Plasmodium falciparum* is the most virulent and prevalent malaria parasite in Nigeria, accounted for 98% of estimated malaria cases The parasites are spread to people through the bites of infected female Anopheles mosquitoes[1;4].

In Nigeria, malaria is endemic and stable. The disease disproportionately affects poor and disadvantaged people, who have limited access to health facilities and can barely afford the recommended treatment. An estimated 65% of Nigeria's population lives in poverty which is one of the major factors in malaria prevention and treatment [5].

The main clinical symptom of malaria is intermittent or periodic fever associated with anaemia and splenomegaly[6]. The large majority of the malaria burden is experienced by children less than 5 years and pregnant women [7]. Some children suffer an acute attack of cerebral malaria that quickly leads to coma and death; others succumb to the severe anaemia that follows repeated infections. Malaria in school children is a major cause of absenteeism and probably reduces effectiveness of their education and social development [8].Many children who survive a serious attack of malaria develop physical and mental impairment [9]. Pregnant women have a higher risk than the non-pregnant ones to be infected with malaria, and they are at increased risk of adverse effects such as anemia, risk of miscarriage, stillbirth, low birth weight, preterm delivery, fetal growth restriction and even death [10]. Malaria in adults has negative impacts on their health and livelihoods. It affects majority in rural areas thereby reduced productivity and hinders economic development [8]. Malaria is endemic in Benue State, transmitted through the bites of infected female Anopheles mosquitoes. These Anopheles species are widely distributed in the areas, due to conducive environmental and climatic conditions. Manyi *et al* in 2014 [4] reported that the temperature might have an impact on malaria transmission in the study area throughout the year.

2. METHODOLOGY

2.1 Study Area

The study was conducted in six randomly selected General Hospitals in Benue State. The General Hospitals located in Adikpo,, Gboko, Naka, Okpoga, Otukpo and Sankera . Benue State is located in the north central of Nigeria, with its capital at Makurdi. Its geographic coordinates are longitude 7° 47' and 10° 0' East. Latitude 6° 25' and 8° 8' North. The State has a total population of 4,253,641 in 2006 census , with an average population density of 99 persons per km2 [11]. Made up of 2,144,043 males and 2,109,598 females the state has a sex ratio of 1.02, a literacy rate of 44.7% among the population aged 6 years and above, and a population density of about 130 persons per square kilometer [11].

Agriculture is the mainstay of the economy, engaging over 75% of the state farming population. Benue State is the nation's food basket because of its rich agricultural produce. The State also boasts of one of the longest stretches of river systems in the country with great potential for a viable fishing industry, dry season farming through irrigation and for an inland water highway. Most of the people are farmers while the inhabitants of the river areas engage in fishing as their primary or important secondary occupation.

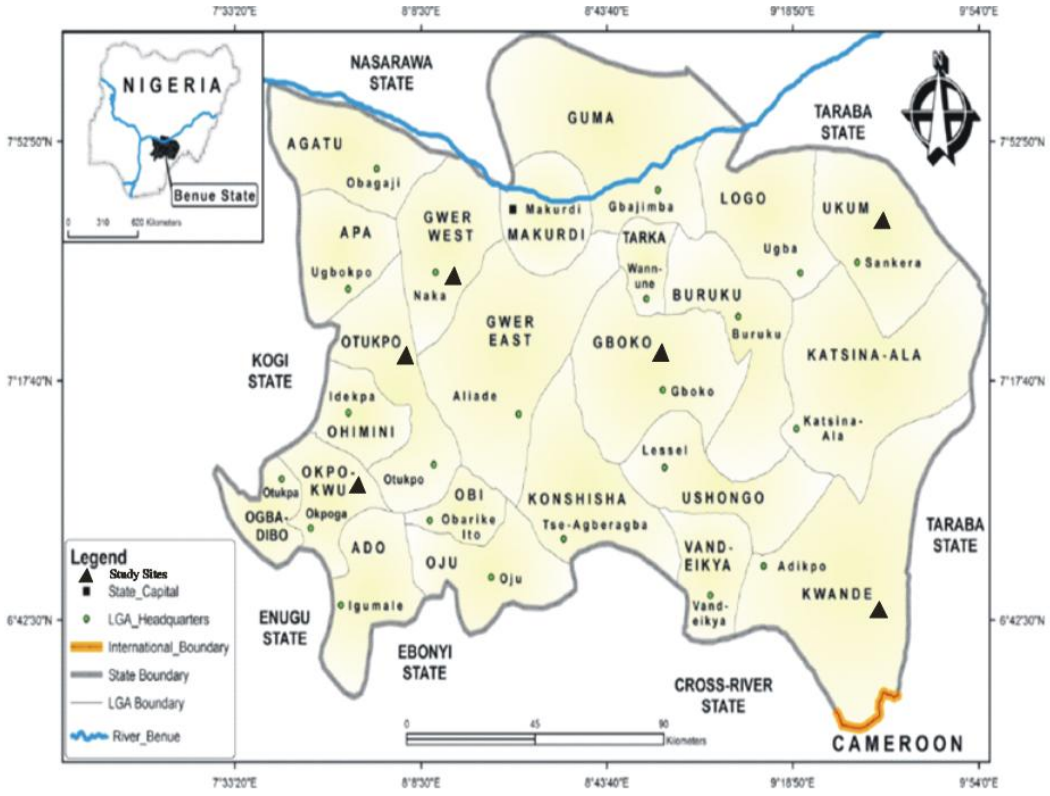

Fig. 1. Map of Benue State, Nigeria (Ministry of Lands and Survey, Makurdi)

2.2 Study Design

2.2.1 Study population

The study was conducted between September,2018 and August,2019. This study was hospital based and it considered only out-patient subjects who were referred to Laboratory department for medical diagnosis. The study population consisted of 1200 subjects, including both children and adults were screen for *Plasmodium falciparum* Infection. Patients' epidemiological data were obtained using questionnaires.

2.2.2 Sample size estimation

The Taro- Yamane's formula and proportional sampling were used for sample size estimation and it gave a minimum of 200 for patients by taking proportion from a previous record.

The Taro- Yamane's formula is given

Thus:

$$n = \frac{N}{1+N\,(e)2} \quad (1)$$

Where:

n = sample size
N = population
e = level of precision or confidence level (0.05)2

The sample was further increased by 5% to account for contingencies such as non-response or recording error.

2.3 Sample Collection and Parasitological Technique

The left thumb of participants was thoroughly cleaned with methylated spirit and a sterile lancet was used to prick the finger to obtain blood sample. Thick and thin blood films were made on clean slides and a drop of the blood was used with an RDT kit, the "CareStart Malaria HRP2 from Access Bio, Inc."and labeled accordingly .

Thick and thin blood films were prepared on microscope slides collected by finger prick blood samples. After proper fixation, the prepared slides were then stained with 10% Giemsa (v/v). Blood films were examined microscopically using X 100 (oil immersion) objectives as described by Cheesbrough [12]. The thick films were used to determine the parasite densities while thin films

were used to identify the parasite species. Parasite density per microliter of blood was estimated from the thick film by taking the number of leucocytes per microliter of blood as 8,000 and expressed as follows:
Parasite density/uL=Parasite count × 8000
/No of WBC counted.

Questionnaire administration: A structured questionnaire was used to collect data on the gender, age, educational status occupation and malaria preventive measures.

2.4 Statistical Analysis

Simple percentage and Chi-squared test were used for data presentation. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) software (version 20.0, SPSS Inc., Chicago, IL., USA). Chi-squared test was used to compare prevalence of malaria infection between age, sex, occupation, educational status and preventive methods of the subjects. The significance level was considered at P≤0.05.

Table 1. Prevalence of *Plasmodium falciparum* infection among patients with respect to location

Location	Number examined	Number infected (%)	Number negative (%)
Adikpo	200	76 (38.0)	124 (62.0)
Gboko	200	43 (21.5)	157 (78.5)
Naka	200	96 (48.0)	104 (52.0)
Okpoga	200	83 (41.5)	117 (58.5)
Otukpo	200	51 (25.5)	149 (74.5)
Sankara	200	69 (34.5)	131 (65.5)
Total	1200	418 (34.8)	782 (65.2)

P<0.05

Table 2. Prevalence of *Plasmodium falciparum* infection among patients with respect to Residence

Residence	Number examined	Number infected (%)	Number negative (%)
Rural	720	304 (42.2)	416 (57.8)
Urban	480	114 (23.8)	366 (76.3)
Total	1200	418 (34.80	782 (65.2)

P <0.05

Table 3. Prevalence of *Plasmodium falciparum* infection among patients with respect to Age

Age (Years)	Number examined	Number infected (%)	Number negative (%)
≤5	113	49 (43.4)	64 (56.6)
6-10	156	85 (54.5)	71 (45.5)
11-15	163	84 (51.5)	79 (48.5)
16-20	82	18 (22.0)	64 (78.0)
21-25	133	54 (40.6)	79 (59.4)
26-30	129	51 (39.5)	78 (60.5)
31-35	90	36 (40.0)	54 (60.0)
36-40	71	19 (26.8)	52 (73.2)
41-45	67	12 (17.9)	55 (82.1)
>46	57	10 (17.5)	47 (82.5)
Total	1200	418 (34.8)	782 (65.2)

P <0.05

Table 4. Prevalence of *Plasmodium falciparum* infection among patients with respect to gender

Gender	Number examined	Number infected (%)	Number negative (%)
Males	535	177 (33.1)	358 (66.9)
Females	665	241 (36.2)	424 (63.8)
Total	1200	418 (34.8)	782 (65.2)

p>0.05

Table 5. Prevalence of *Plasmodium falciparum* infection among patients with respect to educational status

Educational status	Number examined	Number infected (%)	Number negative (%)
Informal education	102	91 (89.2)	11 (10.8)
Primary	386	158 (40.9)	228 (59.1)
Secondary	448	136 (30.4)	312 (69.6)
Tertiary	264	33 (12.5)	231 (87.5)
Total	1200	418 (34.8)	782 (65.2)

P <0.05

Table 6. Prevalence of *Plasmodium falciparum* infection among patients with respect to occupation

Occupation	Number examined	Number infected (%)	Number negative (%)
Unemployed	130	36 (27.7)	94 (72.3)
Farmers	511	296 (57.9)	215 (42.1)
Traders	343	64 (18.7)	279 (81.3)
Civil servants	216	22 (10.2)	194 (89.8)
Total	1200	418 (34.8)	782 (65.2)

P<,0.05

Table 7. Prevalence of *Plasmodium falciparum* infection among patients with respect to preventive measures

Preventive measures	Number examined	Number infected (%)	Number negative (%)
Insecticides/ITNs	477	82 (17.2)	395 (82.8)
Insecticide spray	318	223 (70.1)	95 (29.9)
ITNs	405	113 (27.9)	292 (72.1)
Total	1200	418 (34.8)	782 (65.2)

P<,0.05

3. DISCUSSION

The overall prevalence of *Plasmodium falciparum* infection rate among patients recorded in this study was 34.8% which is considerably moderate.. This is lower than the overall malaria prevalence of 62% in Uli, Anambra State [13]; 79.1% in Ebonyi State [14] and 80.4% in Abia State [15].However, the prevalence was similar to the overall malaria prevalence of 34% in Ogun State [16] and 32.4% in Enugu State [17].The prevalence in this study was higher than 17.o% in Eastern Nigeria [18] and 27.3% in Sokoto State. [19].This infection rate among the patients in Benue State could be related to poor environmental sanitation, and residence in swamps which are favorable conditions for the breeding of Anopheles mosquitoes. The prevalence in relation to location, this study recorded higher prevalence of 48.0% in General Hospital Naka, followed by Okpoga with 41.5% and least was 21.5% in Gboko. The prevalence in the study could be due to climatic factors such as rainfall, temperature and relative humidity together with behavioral patterns of people in the area which promote mosquito breeding and susceptibility of people to mosquito bites. The prevalence in the study locations were comparable to the prevalence of 41.5% -19.7% recorded in six villages of Alulu-Nike community in Enugu State [17].

With regard to residence areas in this study, the rural area recorded higher prevalence of 42.2% while urban recorded 23.8%prevalence. There was significant difference between the rural and urban areas. This could be due to rural environmental factors and behavioural pattern of the pople to preventive measures or could due to low perceiving of mosquito density. This is in contrast with the work done in Kano Northern Nigeria [20] who reported higher prevalence among urban area than rural area in Kano State.

The difference in prevalence of malaria parasite between rural and urban in this study, agreed with National Malaria Control Programme [21] observed that average prevalence in Nigeria stood at 23 urban and 48 in rural areas.

In this study, the highest malaria prevalence was observed in patients of the age groups 6- 10 and 11-15years with 54.5% and 51.5% respectively. While, the least prevalence of 17.5% was recorded in the age groups >4. This contrasts the reports of highest malaria prevalence in older age groups in Benue, Ibaddan and Osogbo [22;23;24]. Malaria prevalence was statistically significant in different age groups($p < 0.05$).The high rates of infection observed among these age groups could be due to low immune system to malaria infection and inadequate protection against mosquito bites. This age groups plays around and they often expose their body thereby prone to mosquito bites. This finding is consistent with the reports of previous study in South-Eastern Nigeria [17] that reported higher prevalence among children (≤ 15 years)of age. The findings of this study are also in contrast with the reported lower infection rate of malaria among the age (≤6-10 years) groups [11]. It was opined that children born to immune mothers are protected against the disease during the first half year of life by maternal antibodies. As they grow older, after continued exposure from multiple infections with malaria parasites over time, they build up an acquired immunity and become relatively protected against the disease and blood stage parasites.

The females were more infected with the rate of 36.2% across the age groups than their male counterparts who had an infection rate of 33.1% and the infection was not statistically significant. This could be due to variation in the physiological process among women which may contribute to lower immunity; also, it could be the nature of women's activities which might have exposed them to mosquito bites. .This was in contrast to similar reports which had indicated higher infections in males than females [24;25]; who reported that gender did not affect the prevalence of malaria among patients.

Prevalence of malaria among different educational groups was highest among non-formal education. Malaria prevalence was statistically significant in different educational level ($p<0.05$).This is in collaborates with the work of done in South-Eastern Nigeria[17] that reported higher malaria prevalence among non-formal education in Alulu-Nike community, Enugu State. Those with high education had low infections. Education improves general awareness and could be that those who have tertiary education had better knowledge and practices how to protect themselves against mosquito bites and malaria transmission, this could be link to economic status which makes it possible for them to afford antimalaria drugs via treatment.

Prevalence of *Plasmodium falciparum* infections among occupational groups suggests that farmers were more prone to malaria infection having recorded highest rate of infection in the study areas. There was statistically significant in different occupational groups ($p<0.05$).This could be attributed to several factors such as poverty or low income, ignorance, poor environmental sanitation and abundant mosquito-breeding sites in the areas improper mosquito preventive measures. This finding is similar to the work of Yohanna *et al* in 2019 [25] who observed that the high prevalence of malaria was recorded among children whose parents /guardians were farmers. Amuta *et al* in 2014 [10] observed that the spread of the disease depends on socio-economic conditions, population mobility, housing, occupation, human habits and immunity.

The Insecticide Treated Nets (ITNs) and insecticide spray are the two main preventive methods widely used in the study areas. The preventive methods are variously effective but the combination of ITNs and Insecticide spray seemed to be more effective than the use of insecticide spray alone. The present study reveals that insecticide spray alone recorded the highest prevalence of 70.1% while, combination of ITNs and Insecticide recorded the least prevalence of 17.9%. The use of insecticide was one of the most preferred methods of mosquito control by many participants, insecticide were applied at least once a week. This could be the cause of high malarial infection rate observed among patients that used insecticide sprays alone, or could be due to mosquitoes resistance to the chemical or to the low quality of the insecticides and the short duration of the insecticide sprays which lasts for few hours only could be another factor. The use of insecticide-treated bed-nets/ Long Lasting Insecticidal Nets (LLINS) has been shown to reduce malaria infections. The prevalence recorded in this study could be due to unavailability of treated nets by those who desired to procure them, or too expensive. Or refusal to sleep under insecticide-treated nets or discomfort primarily due to heat and perceived low mosquito density were the most widely identified for non use of ITNS. The finding is similar to previous report by Manyi *et a*l in 2018 [9] who observed that the high

prevalence rate could be by chance; child's refusal to sleep under insecticide-treated nets or because of ignorance on the part of their parents concerning the use of insecticide-treated nets which make the more prone to infective mosquito bites. Amuta, *et al*. 2014 [10] observed that good result of this combination of preventive methods could just reflect a synergy between the chemical components against mosquitoes. The present study reveals that malaria remains moderately prevalent among patients attending General Hospitals in Benue State, Nigeria, despite the efforts by Government curb the burden of malaria in Nigeria. Combined method of prevention (ITNs and Insecticide spray) yielded good results in preventing malaria among patients in Benue State.

4. CONCLUSION

Malaria is endemic and stable; being a major cause of morbidity and mortality in Nigeria This study has revealed that the malaria infection is considered moderately high compare to other studies. It has also revealed that all age groups are prone to malaria infections, but children (≤ 15 years) are highly vulnerable to malaria attack. There is need to intensify campaigns on preventive and control methods.

CONSENT AND ETHICAL APPROVAL

Permission was sought for and obtained from the Ethical Committee of the Hospitals Management Board, Makurdi. Patients presenting themselves for Laboratory test in the selected General hospitals were duly informed on the significance of the study. Informed consent of adults and parents/ guardians of the children were obtained before blood sample collection for the tests and administration of questionnaire.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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